**SECTION 26 11 16**

**UNIT SUBSTATIONS**

1. **GENERAL**
	1. **DESCRIPTION**
		1. This section specifies the furnishing, installation, connection, and testing of a unit substation, indicated as “substation” in this section.
	2. **QUALITY ASSURANCE**
		1. The equipment furnished under this Section shall be the product of a manufacturer who has produced paralleling switchgear up to 15kV for a period of at least 15 consecutive years.
		2. The switchgear equipment manufacturer shall have all aspects of design, assembly, and testing of the equipment within the same location.
		3. The switchgear manufacturer shall have field service personnel and facility with spare parts. The spare parts stocked at the facility shall include vacuum circuit breakers, automation controllers, control switches and lights, fuses, medium voltage insulators, etc.
	3. **FACTORY TESTS**
		1. Medium-Voltage Switchgear Assembly Tests:
			1. Visual and Mechanical Inspection:
				1. Verify that fuse and switch sizes and types correspond to Drawings and coordination study.
				2. Verify that current and voltage transformer ratios correspond to Drawings.
				3. Inspect bolted electrical connections using calibrated torque-wrench method.
				4. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

Attempt closure on locked-open devices. Attempt to open locked-closed devices.

* + - * 1. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
				2. Inspect insulators for evidence of physical damage or contaminated surfaces.
				3. Verify correct barrier and shutter installation and operation.
				4. Exercise active components.
				5. Inspect mechanical indicating devices for correct operation.
				6. Verify that filters are in place and vents are clear (if applicable).
				7. Perform visual and mechanical inspection of instrument and control power transformers.
				8. Inspect control power transformers.

Inspect for physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.

Verify that primary and secondary fuse or circuit breaker ratings match drawings.

Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

* + - 1. Electrical Tests:
				1. Perform a power frequency dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, according to ANSI C37.20.2 Table 1.

If no evidence of uncontrolled discharge or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

* + - * 1. Control Power Transformers:

Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground.

Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.

Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

* + - * 1. Voltage Transformers:

Perform secondary wiring integrity test. Verify correct potential at all devices.

Verify secondary voltages by energizing the primary winding with system voltage.

* + - * 1. Perform current-injection tests on the entire current circuit in each section of switchgear.

Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

Vary the magnitude of the injected current and verify overcurrent trip of all the overcurrent protective relays.

* + - * 1. Perform system function tests according to "System Function Tests" Article.
				2. Verify operation of space heaters (if applicable).
				3. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.
		1. Metering Devices Tests:
			1. Inspect physical and mechanical condition.
			2. Inspect bolted electrical connections.
			3. Verify all instrument node numbers, multipliers (CT and PT ratios). Instrument multipliers shall be according to system design specifications.
			4. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.
			5. Test meter readings via secondary injection.
		2. Medium-Voltage Surge Arrester Field Tests:
			1. Visual and Mechanical Inspection:
				1. Verify that equipment nameplate data complies with Design Documents.
				2. Inspect physical and mechanical condition.
				3. Inspect anchorage, alignment, grounding, and clearances.
				4. Verify the arresters are clean.
				5. Verify that the ground lead on each device is attached to a ground bus or ground electrode.
			2. Electrical Test:
				1. Microprocessor-Based Protective Relay Field Tests:

Visual and Mechanical Inspection:

Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.

Verify operation of light-emitting diodes, display, and targets.

Record passwords for each access level.

Clean the front panel and remove foreign material from the case.

Check tightness of connections.

Verify that the frame is grounded according to manufacturer's instructions.

Set the relay according to results of the coordination study (if available).

Download and save settings from the relay.

Electrical Tests:

Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.

Functional Operation: Check functional operation of protective function used in the protection scheme as follows via secondary injection of the currents and voltages.

* + 1. System Function Tests:
			1. Conduct testing of the sequence of operation according to the Specification.
			2. Simulate the Power System conditions as required.
			3. Verify operation of every automated sequence.
		2. Perform factory and installation tests in accordance with applicable NEC, NEMA and UL requirements.
		3. Substation shall conform to the dielectric (HI POT) test from UL891.
	1. **SUBMITTALS**
		1. Product Data: Submit manufacturer's printed product data.
		2. Drawings: Submit shop drawings for approval. Include components, materials, finishes, detailed plan and elevation views, openings, and accessories.
	2. **APPLICABLE PUBLICATIONS**
		1. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
		2. American National Standards Institute (ANSI):

C37.54..................Indoor Alternating Current High-Voltage Circuit

Breakers Applied as Removable Elements in Metal-Enclosed Switchgear - Conformance Test Procedures

C37.55..................Medium-Voltage Metal-Clad Assemblies –

Conformance Test Procedures

* + 1. Institute of Electrical and Electronics Engineers (IEEE):

C37.09..................Standard Test Procedure for AC High-Voltage Circuit

Breakers Rated on a Symmetrical Current Basis

C37.20.3................IEEE Standard for Metal-Enclosed Interrupter Switchgear

C37.20.4................IEEE Standard for Indoor AC Switches (1kV-38kV) for Use in Metal-Enclosed Switchgear

C37.22..................IEEE Standard Preferred Ratings and Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear.

C57.13..................Standard Requirements for Instrument Transformers

* + 1. National Electrical Manufacturer's Association (NEMA):

C37.57..................Switchgear-Metal-Enclosed Interrupter Switchgear Assemblies - Conformance Testing

LA 1....................Surge Arrestors

SG-2....................Standards for High-Voltage Fuses

SG-5....................Standards for Power Switchgear Assemblies

SG-6....................Standards for Power Switchgear Equipment

* + 1. National Fire Protection Association (NFPA):

70-11...................National Electrical Code (NEC)

* + 1. International Electrotechnical Commission (IEC):

60694...................Common specifications for high-voltage switchgear and controlgear standards

1. **PRODUCTS**
	1. **SYSTEM RATING**
		1. System Voltage: (2.4/4.16/12.47/13.2/13.8) kV nominal, three-phase, 60 Hz.
		2. Maximum Design Voltage: (4.76/15) kV.
		3. Impulse Withstand (Basic Impulse Level): (60/95) kV.
		4. Power Frequency Withstand: (19/36) kV, 1 minute test.
		5. Fault interrupting and Short Time withstand (2 seconds): (25/40/50) kA RMS Symmetrical
		6. Main Bus Ampacity: (500/1200/2000/3000) amps, continuous.
		7. System X/R ratio: up to 17 without derating
	2. **GENERAL REQUIREMENTS**
		1. Manufacturers: Subject to compliance with requirements, provide switchgear of the following:
			1. Advanced Power Technologies (APT) – Contact Brandon Lopez for quotation.
			2. In order to be an approved manufacturer, the manufacturer seeking to be approved shall send pertinent product information, qualifications, references, and evidence of support capabilities as per section 1.2 of this specification thirty days prior to the bid date to both customer and engineer.
		2. Substation shall be in accordance with ANSI, IEEE, NEMA, NFPA, IEC as shown on the drawings, and have the following features:
			1. Substations shall be a complete, grounded, continuous-duty, integral assembly, dead-front, dead-rear, self-supporting, skid-mounted substation assembly. Incorporate devices shown on the drawings and all related components required to fulfill operational and functional requirements.
			2. Substation shall be supplied as a complete system and shall include all the necessary components and equipment to accommodate described system operation unless otherwise noted.
			3. Substation shall conform to the arrangements and details shown on the drawings.
			4. Substation shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Adequate ventilation within the enclosure shall be provided.
			5. All non-current-carrying parts shall be grounded.
			6. All major components (Medium Voltage Switchgear, Transformer, and Low Voltage Switchboard) shall be mounted on a base constructed of structural steel. Adequate lifting provisions to accommodate both a fork truck and a crane shall be provided.
			7. Packaging shall include the skid-mounted substation to be stretch wrapped to provide adequate protection against rough handling during shipment.
	3. **INCOMING MEDIUM VOLTAGE LINE EQUIPMENT**
		1. Incoming line equipment shall be rated (2.4/4.16/12.47/13.2/13.8) kV nominal, three-phase, 60 Hz.
		2. Incoming line equipment shall be draw-out circuit breaker based, suitable for top or bottom cable entry as shown on the Drawings, and shall be as specified in Section 26 13 13.
	4. **TRANSFORMERS**
		1. The transformer shall be close-coupled to the incoming line equipment and secondary switchboard.
		2. The transformer shall be as specified in Section 26 12 16.
	5. **SECONDARY SWITCHBOARD**
		1. The secondary switchboard shall be connected by the manufacturer to the transformer.
		2. The secondary switchboard shall be as specified in Section 26 23 00.
2. **EXECUTION**
	1. **INSTALLATION**
		1. The substation shall be mounted on steel channels furnished under this Section, set flush with the concrete pad and level in all directions. The substation shall be bolted to the pad with not less than 1/2-in bolts.
	2. **FIELD TESTING**
		1. Testing and checking the incoming line equipment, transformer, and switchgear shall be as specified in other related Sections.
	3. **COMMISSIONING**
		1. Install switchgear in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
		2. Commissioning shall be performed by the substation manufacturer.
		3. Commissioning shall commence once system components are in place and the contractor has indicated the system is ready for activation.
		4. Training shall be performed by the substation manufacturer. The manufacturer shall include training for the owner’s staff. This training shall consist of hands on demonstrations of varying states of the switchgear and the proper sequence of events that should occur with instructions on how to deal with varying scenarios. Include detailed written instructions for the successful operation of the substation.

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